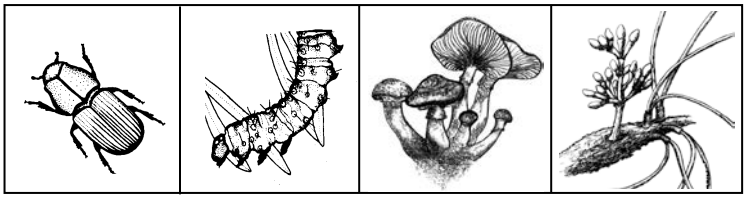
Forest Health Protection



14-06 **June 2014**

Mountain pine beetle status and mortality trends from 2012 to 2013 in Montana and northern Idaho subwatersheds

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Executive Summary

Mountain pine beetle (*Dendroctonus ponderosae* Hopkins) (MPB) activity has caused extensive pine mortality throughout the Northern Region over the past decade (Man 2012). Annual pest activity and outbreak status is surveyed across the Northern Region through aerial detection survey (ADS) flights. A synopsis of MPB activity and trends is provided at the subwatershed level with a methodology that respects the limitations of ADS data.

MPB-caused mortality continued, at a declining rate, throughout a majority of subwatersheds within the Northern Region in 2013 as was detected in 2012 (Egan et al. 2013). Subwatersheds with the highest level of MPB activity included Beaverhead, Granite, and Ravalli counties in Montana as well as Idaho, Clearwater, and Shoshone counties in Idaho. The majority of subwatersheds surveyed in 2013 (57%) had low levels of MPB activity detected while relatively fewer subwatersheds (9%) had substantial MPB activity. MPBs were most active in the Bitterroot, Sapphire, Clearwater, and Beaverhead, and Big Snowy Mountain ranges. Trend comparisons with data collected in 2012 were valid for 53% of the subwatersheds that were surveyed in 2013. MPB activity was not present or declined within 69% of subwatersheds where trend comparisons were valid. Areas with decreased MPB activity had a 5-fold median rate of decline. Locations that did not match this trend included the Bitterroot, Sapphire, and Clearwater Mountain ranges where numerous subwatersheds had increasing mortality trends and substantial MPB activity detected in 2013. Areas with increased MPB activity had a 2.8-fold median rate of increase.

Introduction

Information collected for monitoring forest pest activity is obtained through infrequent and spatially limited ground surveys and extensive aerial detection surveys. Other remote sensing, such as satellite imagery, have shown promise to detect vegetative change; however, these

technologies are not currently able to detect numerous, often subtle, agent-specific damages that aerial survey technicians can distinguish (Wulder et al., 2006; Meddens et al., 2012). Thus, ADS represents the best-available information to monitor and assess insect activity and trends over a landscape spatial scale. However, these data have limitations.

Aerial survey data collected are not validated to the point where standard error rates for measurements can be quantified to support statistical comparisons. Limited quality checks are conducted to ensure that data meets minimum nationally regulated quality standards (see www.fs.fed.us/foresthealth/aviation/qualityassurance.shtml for details).

Error in aerial survey data estimations can occur within the following areas:

- Spatial extent attributed to damage (point/polygon size or area)
- Spatial location of damage (point/polygon location, spatial location of damage boundary)
- Damage severity estimated (trees within polygon or per acre for mortality estimates)
- Damage agent attributed (damaging species or abiotic agent)
- Identification of damage where none exists (false positive)
- Failure to identify damage where it does exist (false negative)

Conclusions from one of the only studies assessing ADS error indicates assessments at a coarse spatial scale are reasonable while fine scale analyses are not (Johnson and Ross, 2008). To respect the limitations of ADS with its limited error validation, data are aggregated to a larger spatial scale to minimize the importance of data collection errors regarding location and damage severity estimates. Damage severity for bark beetle-caused mortality (trees per given area) are known to be substantially underestimated (pers. comm. S. Sontag); thus, the severity data presented should be considered conservative estimates.

The spatial scale utilized to summarize and compare mortality is a 6th level or Huc-12 subwatershed (Seaber et al., 1987). Subwatershed boundaries are based on fine-scale topographic features that can impact bark beetle population dispersal and disturbance levels (de la Giroday et al., 2012; Kaiser et al., 2012). This unit is complementary to recent national-level assessments to provide guidance for restoration efforts (USDA FS, 2011).

The goal of this study was to spatially document mountain pine beetle impacts and trends that occurred in 2013 across the Northern Region. Specific objectives were to 1) document MPB activity through damage severity estimates and 2) assess and document MPB-caused mortality trends within subwatersheds in 2013 relative to 2012, and 3) identify counties in Montana and northern Idaho with substantial MPB activity.

Methods

Geospatial information used for this analysis included 6th-level, Huc-12 subwatersheds and annual FHP aerial survey damage that were obtained from Regional geospatial library archives. There were approximately 4,000 subwatersheds within the Northern Region that have a pine species component. These subwatersheds varied in size and averaged 35 square miles (Table 1).

Table 1. Area within Northern Region Huc-12 subwatersheds with pine species component

Variable	n	Mean	Median	Std Dev	Min	Max
Area (acres)	~ 4,000	22,497	21,246	9,826	4,395	210,613
Area (square miles)	~ 4,000	35	33	15	7	329

Methodology for data calculations and geospatial manipulations are provided in detail within the Methods section of Egan et al. (2013) which documents 2012 MPB status and trends throughout the Northern Region.

Table 2. Categories representing MPB activity levels estimated within subwatersheds

Variable	Mathematical delineation
None	0 stems killed by MPB per subwatershed
Low	1 - 999 stems killed per watershed
High	1000 - 9999 stems killed per watershed
Very High	$\geq$ 10,000 stems killed per watershed

MPB-caused mortality severity data were aggregated within subwatersheds for respective 2012 and 2013 survey flights and summarized into broad status or activity level categories (Table 2).

MPB trend information was determined by calculating a ratio by dividing MPB stems killed in 2013 by MPB stems killed in 2012 within each subwatershed. Trends were only calculated for those subwatersheds that had $\geq$ 75% overlap in the area surveyed between 2012 and 2013. Trend information was interpreted from categories depicted in Table 3.

Table 3. Categories representing trend information from ratio of MPB activity in 2013 relative to 2012

Trend Category	Mathematical definition
Declining mortality	> 20% decrease in MPB activity in 2013 vs 2012
Continued mortality	MPB activity in 2013 within 20% of 2012 values
Increasing mortality	> 20% activity in MPB intensity in 2013 vs 2012

ADS estimates tree mortality that typically is expressed one year following MPB-attack. Thus, status and trend information is useful to depict mortality information but should not replace ground surveys to assess local MPB population levels. The status and trend information should be useful to help identify locations to implement ground surveys to determine current population status.

Results

More subwatersheds were surveyed in 2013 relative to 2012 (Figures 1-2 and Figure 4). The majority of subwatersheds surveyed (57%) had low levels of MPB activity detected in 2013. Fewer subwatersheds had no MPB activity (34%), high levels of MPB activity (6%), or very high levels of MPB activity (3%) (Figure 4). The number of subwatersheds with high levels of MPB activity decreased in 2013 relative to 2012 although the area surveyed differed slightly between these years.

In 2013, low levels of MPB activity were detected within subwatersheds throughout the Northern Region (Figure 2). Subwatersheds with high and very high MPB activity were primarily in the Bitterroot, Clearwater, Beaverhead, and Big Snowy Mountain ranges.

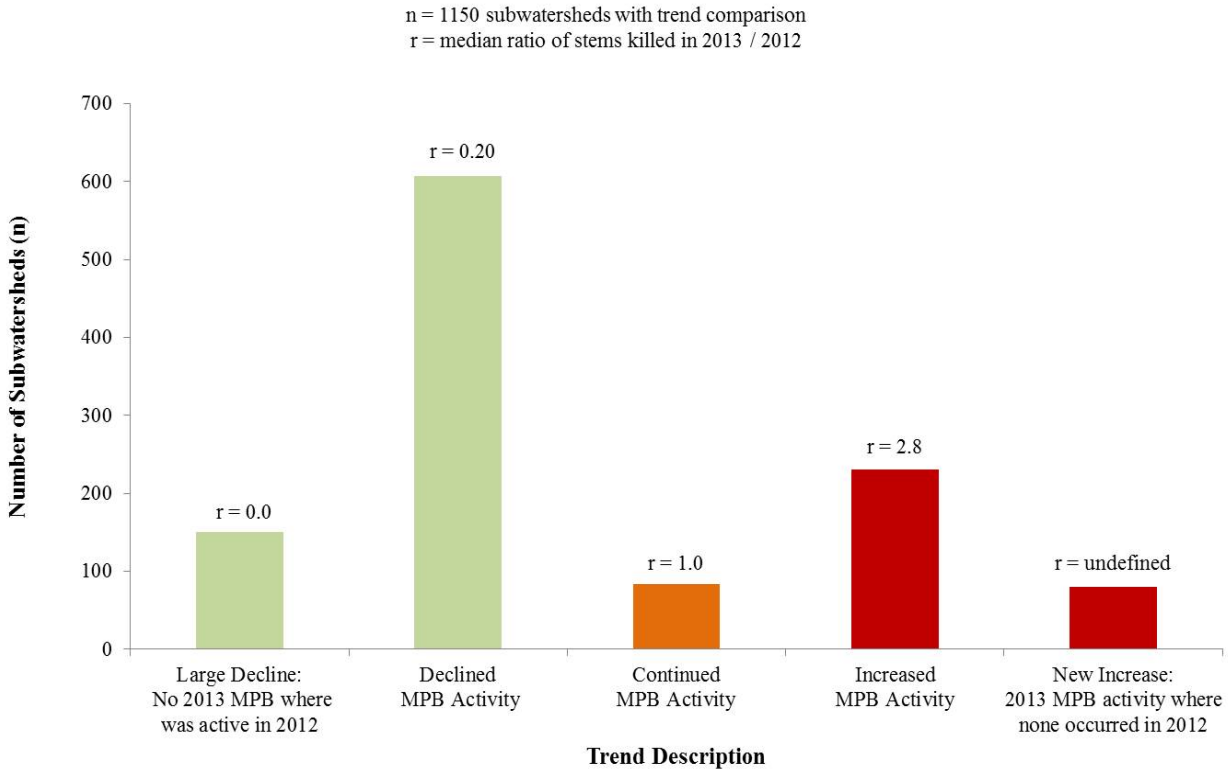
Overall, 53% of the 2,454 subwatersheds surveyed in 2013 had sufficient overlap with 2012 surveys to facilitate trend comparisons. MPB trends continued to decline in the vast majority of subwatersheds surveyed in 2013 as similar to that detected in 2012 although some locations, typically west of the Continental Divide, showed increased mortality trends (Figures 3 and 4).

Where trend comparisons were valid, approximately 69% of subwatersheds in 2013 had either no MPB activity detected or mortality levels that declined (Figure 4). The median rate of mortality was reduced 5-fold within subwatersheds in 2013 relative to 2012 (Chart 1). Of subwatersheds that declined, 20% had substantial drop-offs where MPB activity was not detected at all in 2013. Of note, MPB activity declined substantially within the Purcell, Big Belt, and Swan Mountain ranges.

Conversely, 24% of subwatersheds had mortality levels that increased in 2013 (Figure 4). Subwatersheds with an increasing mortality trend were primarily west of the Continental Divide within the Bitterroot, Clearwater, and Beaverhead Mountain ranges although some were scattered across the Region as well (Figure 3). Of those subwatersheds that had increased MPB activity, many of them had low activity levels and 26% of them were in areas that did not have MPB activity detected in 2012. This may indicate emerging outbreaks and further ground checks are recommended. These subwatersheds were scattered throughout the Region, with many located in northern Idaho and northwestern Montana (Figure 3).

A few scattered subwatersheds, or 7% of all those surveyed in 2013, had similar levels of continued MPB activity detected in 2012 and 2013 (Figure 3; Chart 1).

Chart 1. Number of subwatersheds in the Northern Region by MPB Trend in 2013 relative to 2012



Areas that had high and very high levels of MPB activity in 2013 were separated to display trend information only for those locations with substantial pest activity. In majority of these subwatersheds, MPB trend information indicated an increasing mortality trajectory in 2013 relative to 2012 (Figure 5). This increasing mortality in areas with high and very high levels of MPB activity occurred primarily within the Bitterroot, Clearwater, and Beaverhead Mountain ranges.

Counties within the Northern Region that had the greatest levels of MPB activity detected in 2013 included Beaverhead, Granite, and Ravalli counties in Montana and Idaho, Clearwater, and Shoshone counties in Idaho. Subwatersheds with very high levels of MPB-caused mortality are listed by county within Appendix A for Montana and Appendix B for Idaho.

Conclusions

Overall, MPB-caused mortality continued at a declining trajectory throughout the majority of subwatersheds within the Northern Region in 2013. Subwatersheds within Beaverhead, Granite, and Ravalli counties in Montana as well as Idaho, Clearwater, and Shoshone counties in Idaho had the highest levels of MPB activity.

Fewer subwatersheds had high levels of MPB activity in 2013 relative to 2012 although surveyed area differed slightly between these years. Portions of the Bitterroot, Sapphire, Clearwater, Beaverhead, and Big Snowy Mountains had the greatest levels of ongoing MPB activity detected in 2013.

Trend comparisons were possible for 53% of the subwatersheds surveyed in 2013. The vast majority (69%) of those subwatersheds had MPB activity that declined or was absent. Mortality levels declined at a median rate of 5-fold in subwatersheds with decreasing trends. Locations that did not match this trend included portions of the Bitterroot, Sapphire, and Clearwater Mountain ranges where many subwatersheds had increased activity as well as high to very high mortality levels detected. See Figure 3 for site-specific trend information across the Northern Region and Figure 5 for trend information specifically where MPBs caused substantial tree mortality.

Further detailed information, including specific MPB activity locations at a resolution smaller than the subwatershed scale, can be found within aerial survey maps and data available through: http://www.fs.usda.gov/detail/r1/forest-grasslandhealth/?cid=stelprdb5410518 .

Figure 1. Mountain pine beetle activity detected in subwatersheds throughout the Northern Region in 2012

Note: Red and purple respectively indicate subwatersheds with high and very high levels of MPB activity detected

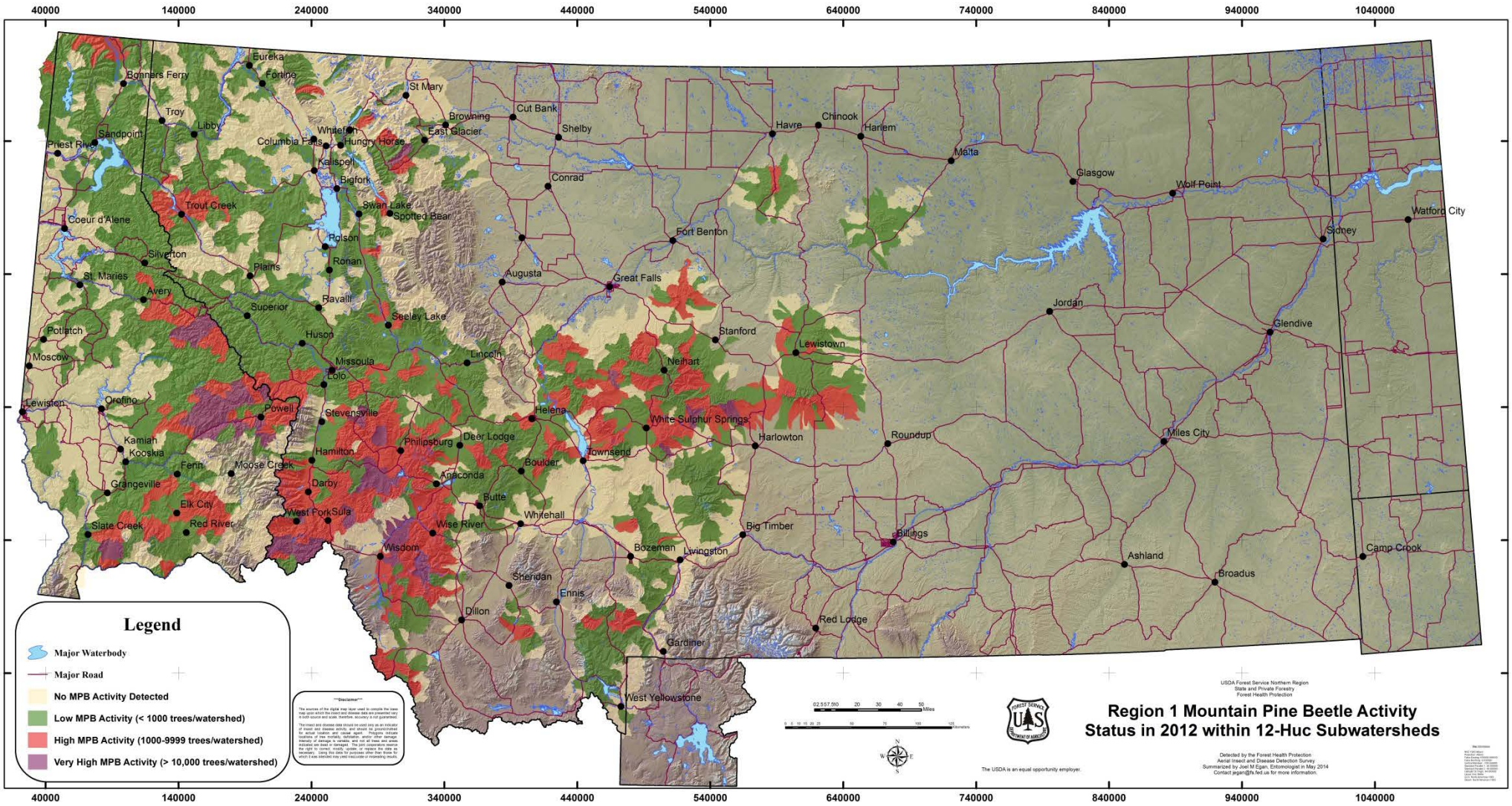


Figure 2. Mountain pine beetle activity detected in subwatersheds throughout the Northern Region in 2013

Note: Red and purple respectively indicate subwatersheds with high and very high levels of MPB activity detected

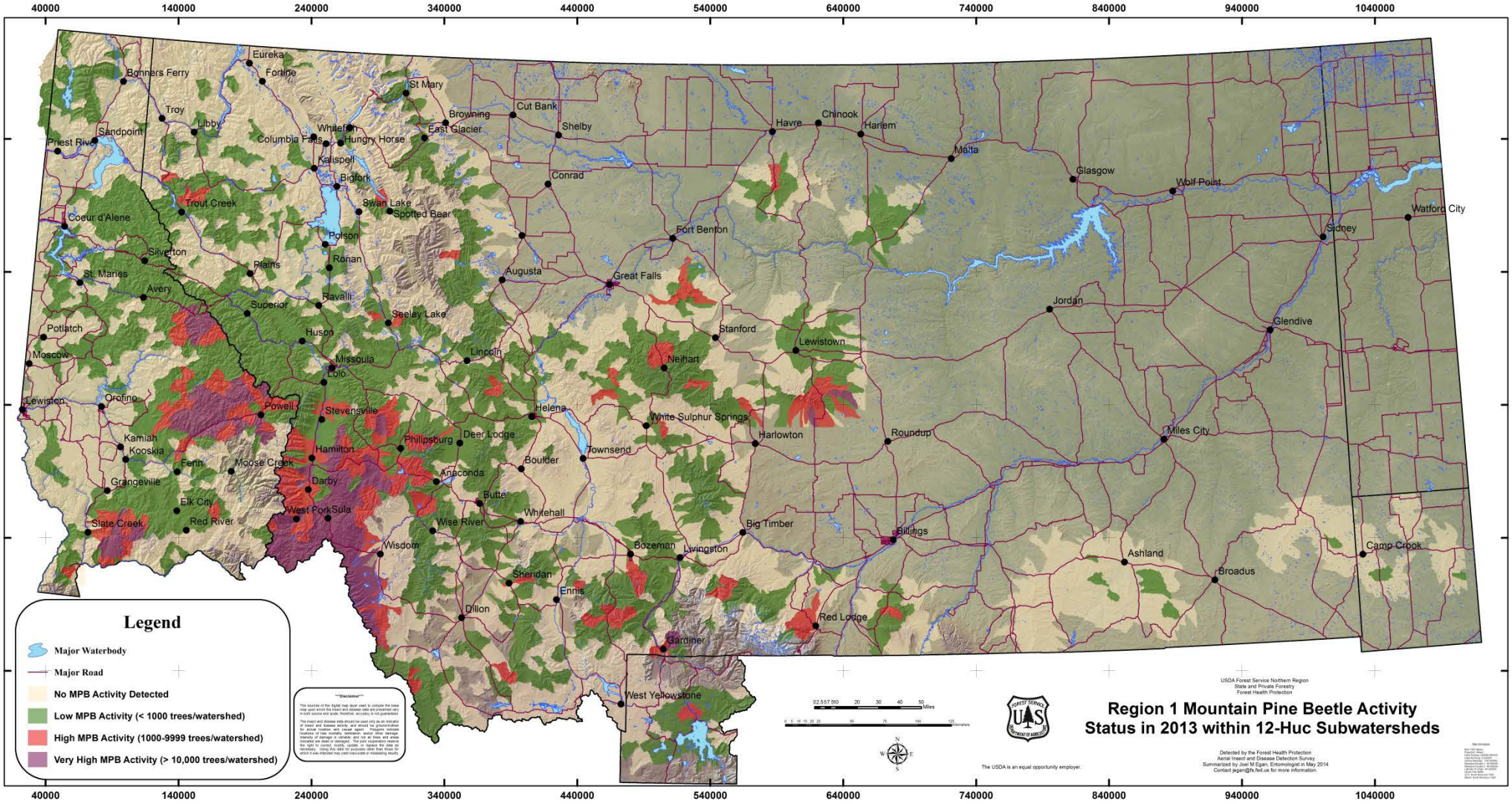


Figure 3. Mountain pine beetle impact trend in 2013 as compared to 2012 within the Northern Region

Note: Teal and red indicate subwatersheds where MPB activity respectively decreased or increased in 2013

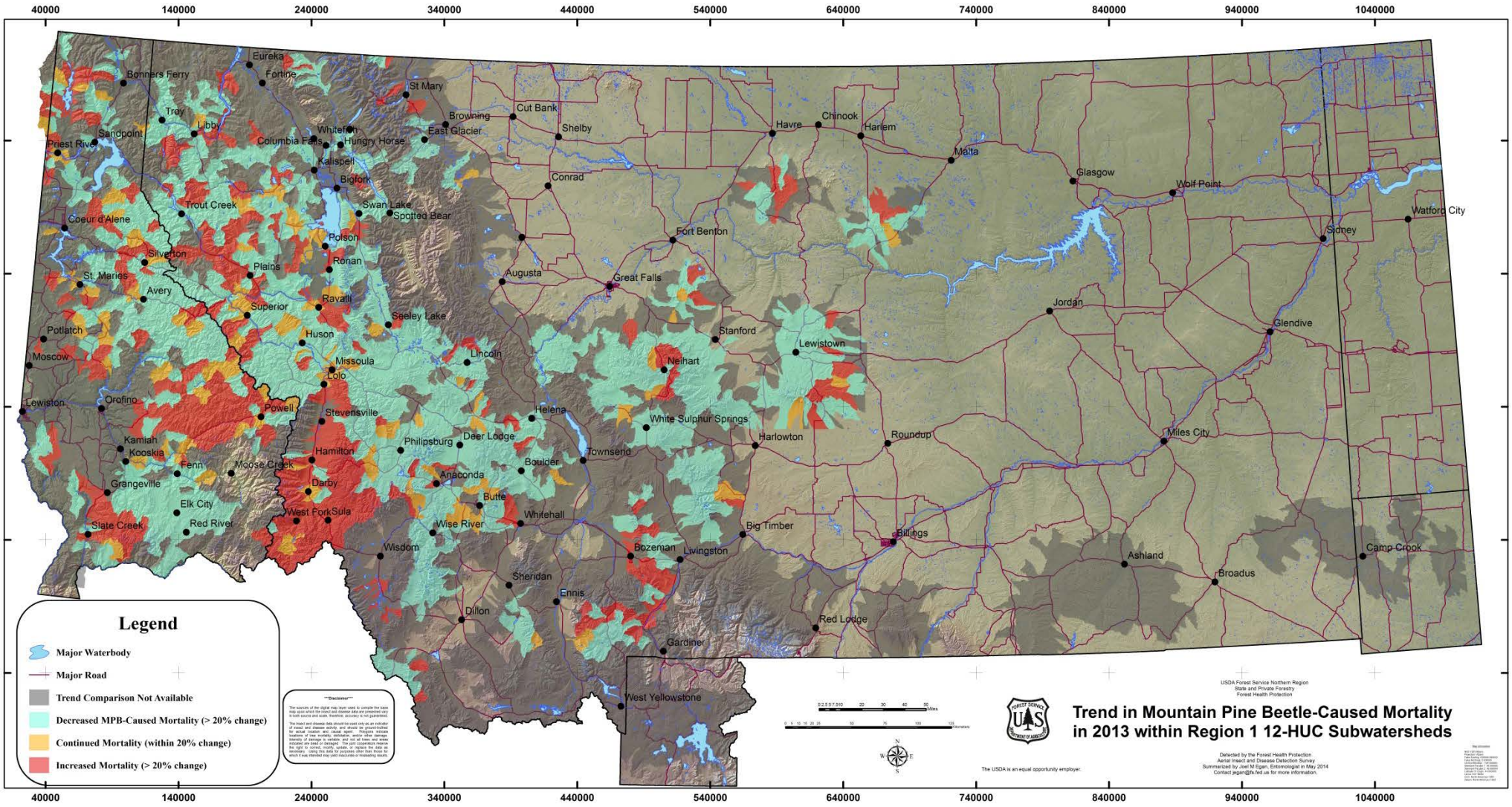


Figure 4 Mountain pine beetle status and trend within Northern Region subwatersheds in 2012 and 2013

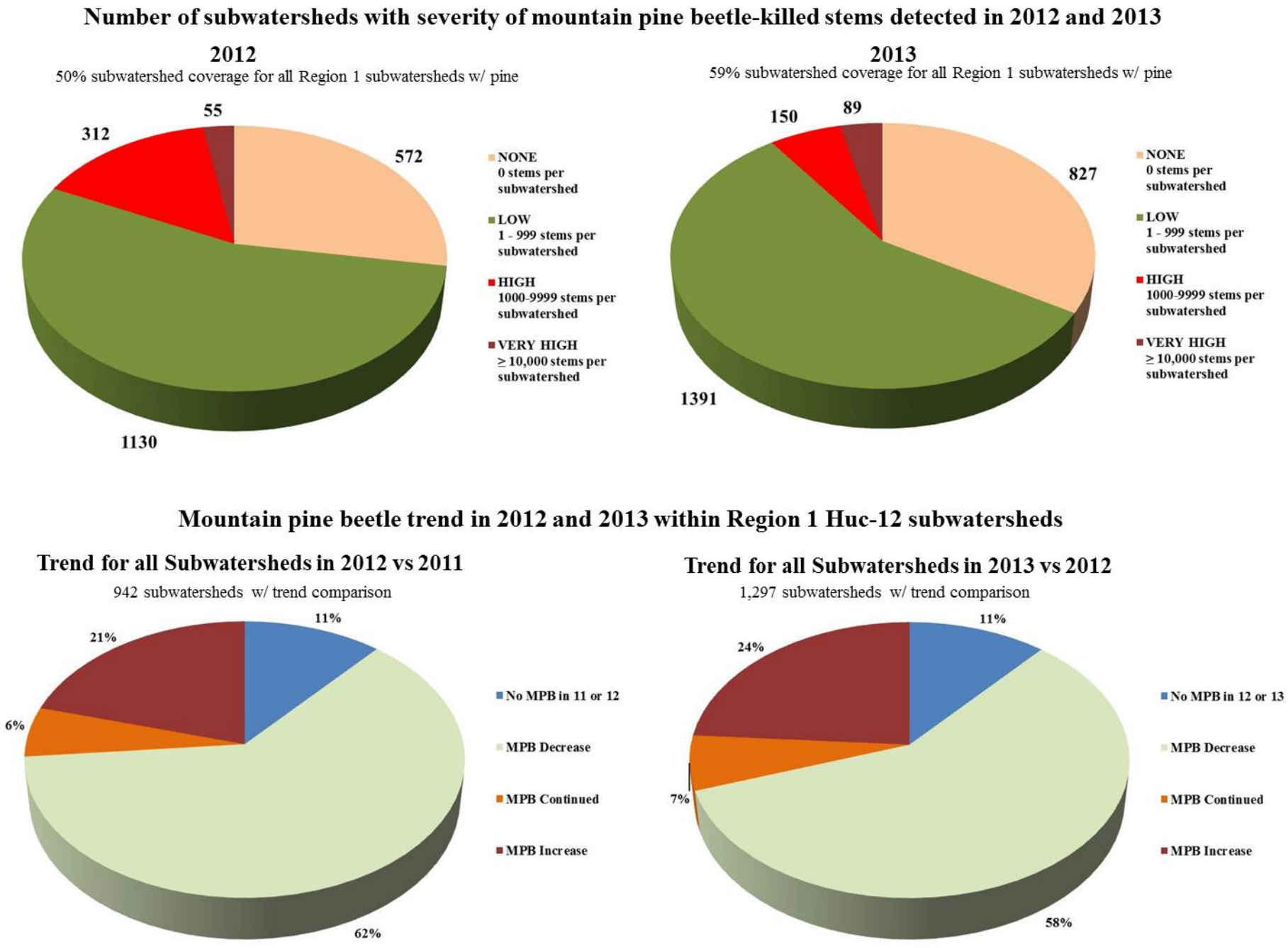
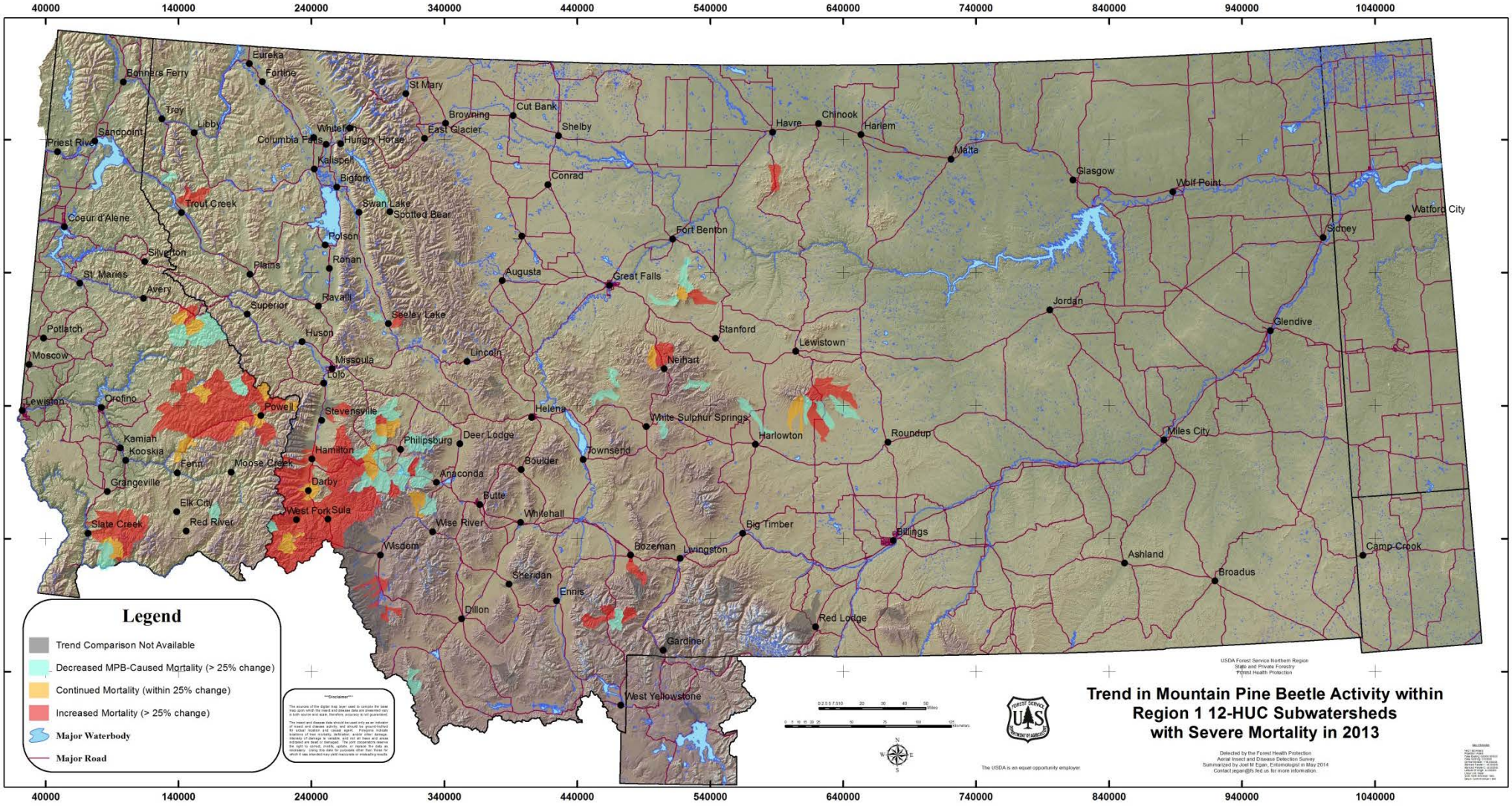


Figure 5. Mountain pine beetle trend in 2013 compared to 2012 within Northern Region subwatersheds where high MPB activity (> 1,000 trees) was detected in 2013.

Note: Teal and red indicate watersheds where MPB-caused stem mortality estimates respectively decreased and increased in 2013



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Appendix A. Subwatersheds with very high (≥ 10,000 trees) MPB activity detected within Montana in 2013

Beaverhead County, Montana

Huc-12 Subwatershed	Estimated Trees Killed by MPB	Huc-12 Subwatershed Number
Big Lake Creek	49,931	276
Big Swamp Creek	34,222	993
Englejard Creek	38,275	989
Headwaters Big Hole River	13,565	986
Johnson Creek	19,045	288
Little Lake Creek	29,010	992
Lower Ruby Creek	103,808	286
Lower Trail Creek	44,665	284
May Creek	67,659	283
Miner Creek	21,868	991
North Branch Big Swamp Creek-Big Hole River	23,634	994
Swamp Creek	48,886	280
Tie Creek	21,733	287
Upper Bloody Dick Creek	10,177	884
Upper Rock Creek	73,575	277
Upper Ruby Creek	93,494	285
Upper Trail Creek	141,725	282
Total	**835,273**	

Fergus County, Montana

Huc-12 Subwatershed	Estimated Trees Killed by MPB	Huc-12 Subwatershed Number
Headwaters Willow Creek	22,686	2016
Total	**22,686**	**2016**

Golden Valley County, Montana

Huc-12 Subwatershed	Estimated Trees Killed by MPB	Huc-12 Subwatershed Number
Headwaters Willow Creek	22,686	2016
Upper Merrills Springs Creek	14,407	1992
Total	**37,093**	

Granite County, Montana

Huc-12 Subwatershed	Estimated Trees Killed by MPB	Huc-12 Subwatershed Number
Lower Middle Fork Rock Creek	12,895	760
Lower Ross Fork Rock Creek	15,636	763
Lower West Fork Ross Creek	11,700	767
Meadow Creek	12,702	1399
Middle Ross Fork Rock Creek	19,149	762
Upper Upper Willow Creek	14,305	769
Upper Willow Creek Headwaters	13,132	768
Total	**99,520**	

Musselshell County, Montana

Huc-12 Subwatershed	Estimated Trees Killed by MPB	Huc-12 Subwatershed Number
Headwaters Willow Creek	22,686	2016
Total	**22,686**	

Park County, Montana

Huc-12 Subwatershed	Estimated Trees Killed by MPB	Huc-12 Subwatershed Number
Bear Creek	10,621	373
Total	**10,621**	**373**

Ravalli County, Montana

Huc-12 Subwatershed	Estimated Trees Killed by MPB	Huc-12 Subwatershed Number
Bitterroot River-Lick Creek	14,664	367
Cameron Creek	49,759	1303
Camp Creek	29,687	1301
Deer Creek	11,292	335
Divide Creek	14,422	1308

Ravalli County, Montana (Continued)

Huc-12 Subwatershed	Estimated Trees Killed by MPB	Huc-12 Subwatershed Number
East Fork Bitterroot River-Bartie Lord Creek	51,239	1299
East Fork Bitterroot River-Jennings Camp Creek	33,240	1302
East Fork Bitterroot River-Laird Creek	24,832	1305
Gird Creek	10,168	1315
Hughes Creek	188,663	337
Little West Fork	25,609	781
Lower Blue Joint Creek	16,452	776
Lower Burnt Fork Bitterroot River	16,612	1330
Martin Creek	86,701	1296
Meadow Creek	65,525	1298
Middle Skalkaho Creek	13,654	1310
Middle Sleeping Child Creek	18,263	358
Moose Creek	35,817	1295
Nez Pierce Fork-Nelson Lake	15,244	782
Overwhich Creek	57,583	774
Tolan Creek	11,165	1300
Upper Blue Joint Creek	22,525	775
Upper Rye Creek	16,270	361
Upper Skalkaho Creek	28,274	369
Upper Sleeping Child Creek	12,757	1309
Warm Springs Creek	58,592	1304
Watchtower Creek	12,675	780
West Fork Bitterroot River-Beaver Creek	101,878	336
West Fork Bitterroot River-Lloyd Creek	26,774	1294
West Fork Bitterroot River-Painted Rock Lake	12,590	778
Willow Creek	10,366	1317
Total	**1,093,294**	

Shoshone County, Idaho

Huc-12 Subwatershed	Estimated Trees Killed by MPB	Huc-12 Subwatershed Number
Bruin Creek-St Joe River	32,036	3198
Copper Creek-St Joe River	34,798	3191
Simmons Creek	16,412	3190
Timber Creek-St Joe River	19,710	3189
Total	**102,956**	**3192**

Appendix B. Subwatersheds with very high (≥ 10,000 trees) MPB activity detected within Idaho in 2013

Clearwater County, Idaho

Huc-12 Subwatershed	Estimated Trees Killed by MPB	Huc-12 Subwatershed Number
Fourth of July Creek	22,063	77
Gravey Creek	29,687	56
Johnny Creek	26,766	72
Middle Cayuse Creek	30,786	58
Middle Creek	11,953	70
Middle Weitas Creek	60,026	68
Monroe Creek	71,807	57
Toboggan Creek	38,027	59
Upper Cayuse Creek	48,883	721
Upper Crooked Fork Creek	10,194	562
Upper Kelly Creek	45,255	65
Total	**395,447**	

Idaho County, Idaho

Huc-12 Subwatershed	Estimated Trees Killed by MPB	Huc-12 Subwatershed Number
Bald Mountain Creek-Lochsa River	80,353	585
Gravey Creek	29,687	56
Hungery Creek	37,520	616
Little Weitas Creek	39,264	69
Lower Big Sand Creek	13,747	568
Lower Fish Creek	13,710	617
Lower Little Slate Creek	80,411	457
Lower Warm Springs Creek	30,230	579
Meadow Creek	69,931	244
Middle Cayuse Creek	30,786	58
Middle Creek	11,953	70
Middle Weitas Creek	60,026	68
Mill Creek	27,102	655
Stanley Creek-Lochsa River	99,231	583

Idaho County, Idaho (Continued)

Huc-12 Subwatershed	Estimated Trees Killed by MPB	Huc-12 Subwatershed Number
Upper Cayuse Creek	48,883	721
Upper Crooked Fork Creek	10,194	562
Upper Johns Creek	29,598	652
Upper Little Slate Creek	41,467	456
Upper Slate Creek	22,492	458
Upper Weitas Creek	58,425	67
Walton Creek-Lochsa River	11,384	573
Weir Creek-Lochsa River	41,842	582
Total	**888,236**	

Shoshone County, Idaho

Huc-12 Subwatershed	Estimated Trees Killed by MPB	Huc-12 Subwatershed Number
Bruin Creek-St Joe River	32,036	3198
Copper Creek-St Joe River	34,798	3191
Simmons Creek	16,412	3190
Timber Creek-St Joe River	19,710	3189
Total	**102,956**	